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(54) **GROUND-ENGAGEABLE ATTACHMENT FOR A VEHICLE**

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E02F 9/00 (2006.01)

(52) **U.S. Cl.**
CPC ***E02F 9/085*** (2013.01); *E02F 9/006* (2013.01)

(58) **Field of Classification Search**
CPC E02F 9/085; E02F 9/006
See application file for complete search history.

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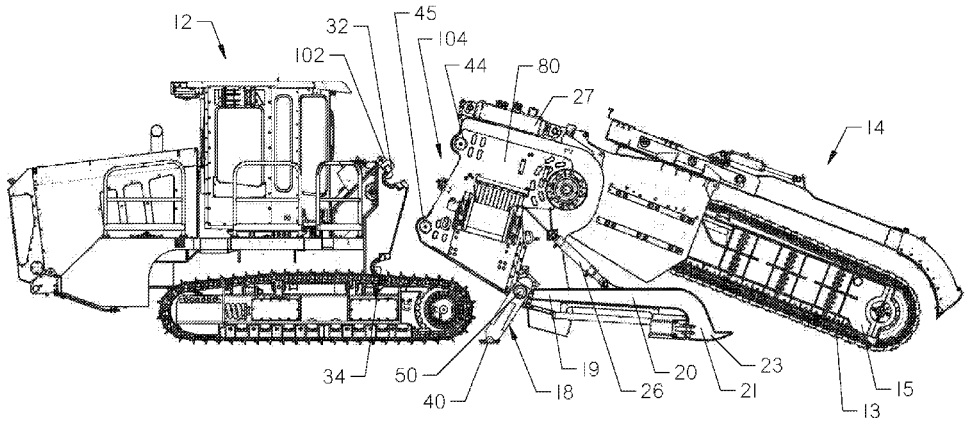
(57) **ABSTRACT**

A work machine is formed from a self-propelled land travel vehicle and an attachment. The vehicle and attachment have interlocking coupling assemblies. The attachment has a positioning arm, a pivot fixture and a ground-engageable frame. The positioning arm and frame allow the attachment to pivot about the pivot fixture to couple and decouple with the vehicle. Coupling and decoupling of the vehicle and apparatus can be achieved without the use of separate lifting equipment.

21 Claims, 8 Drawing Sheets



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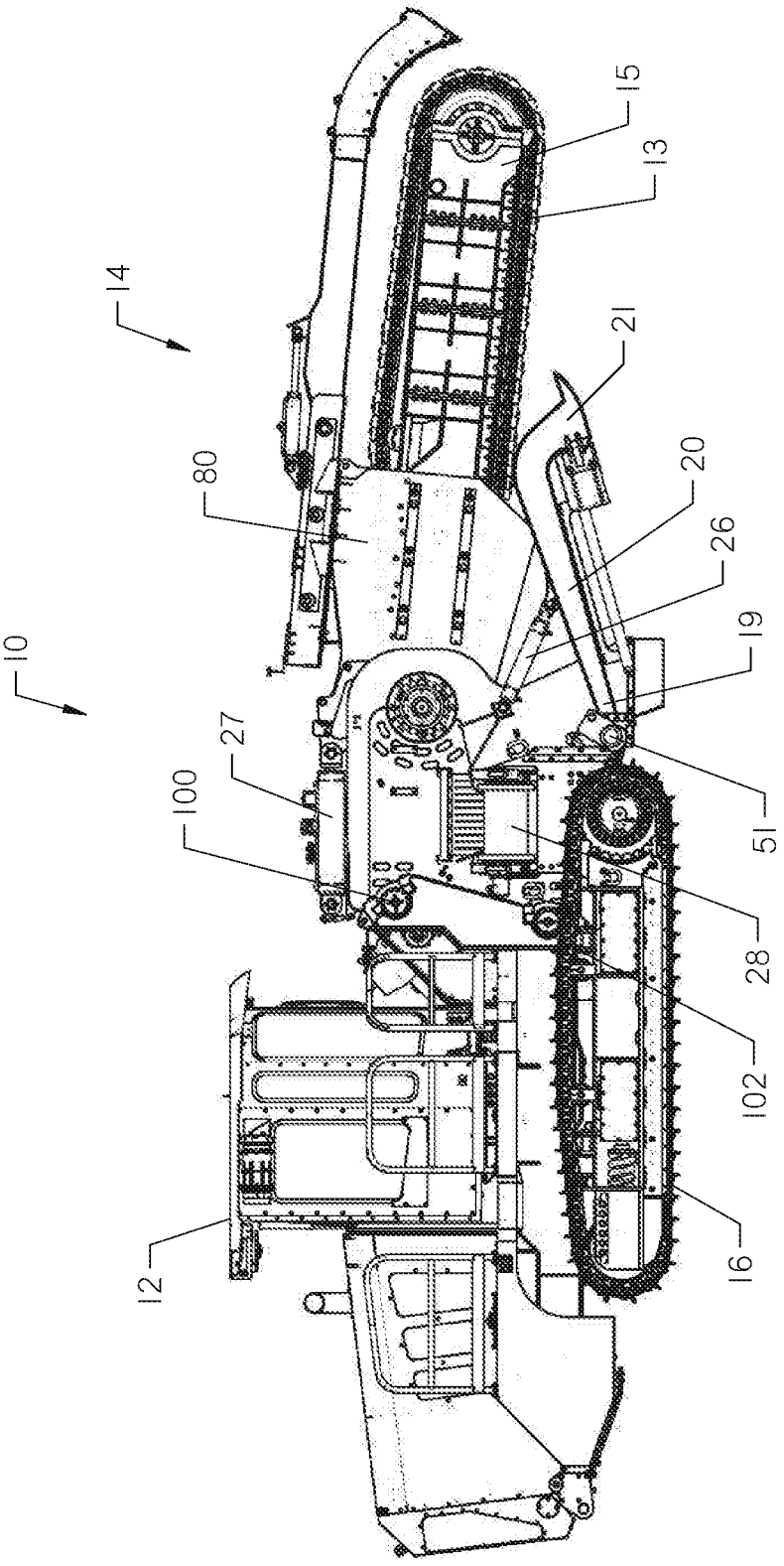

FIG. 1

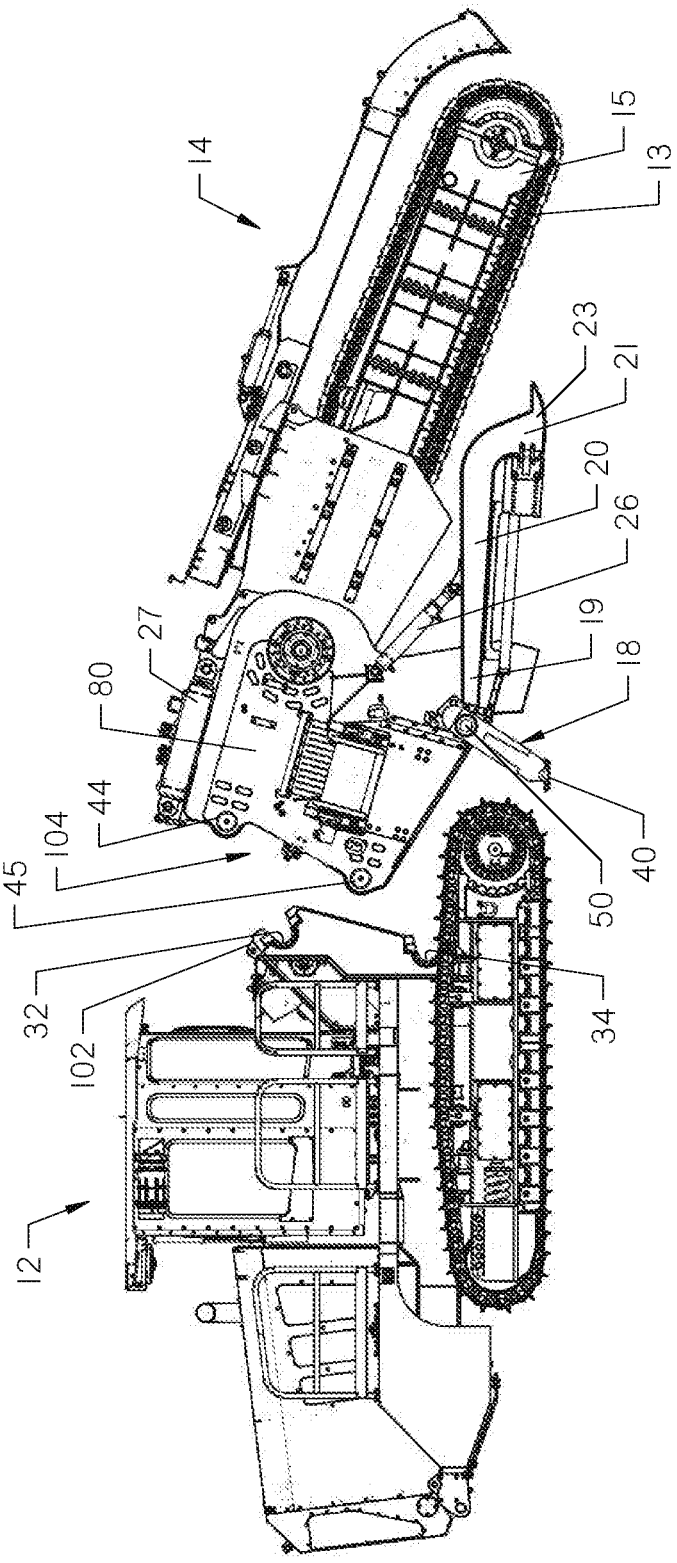

FIG. 2

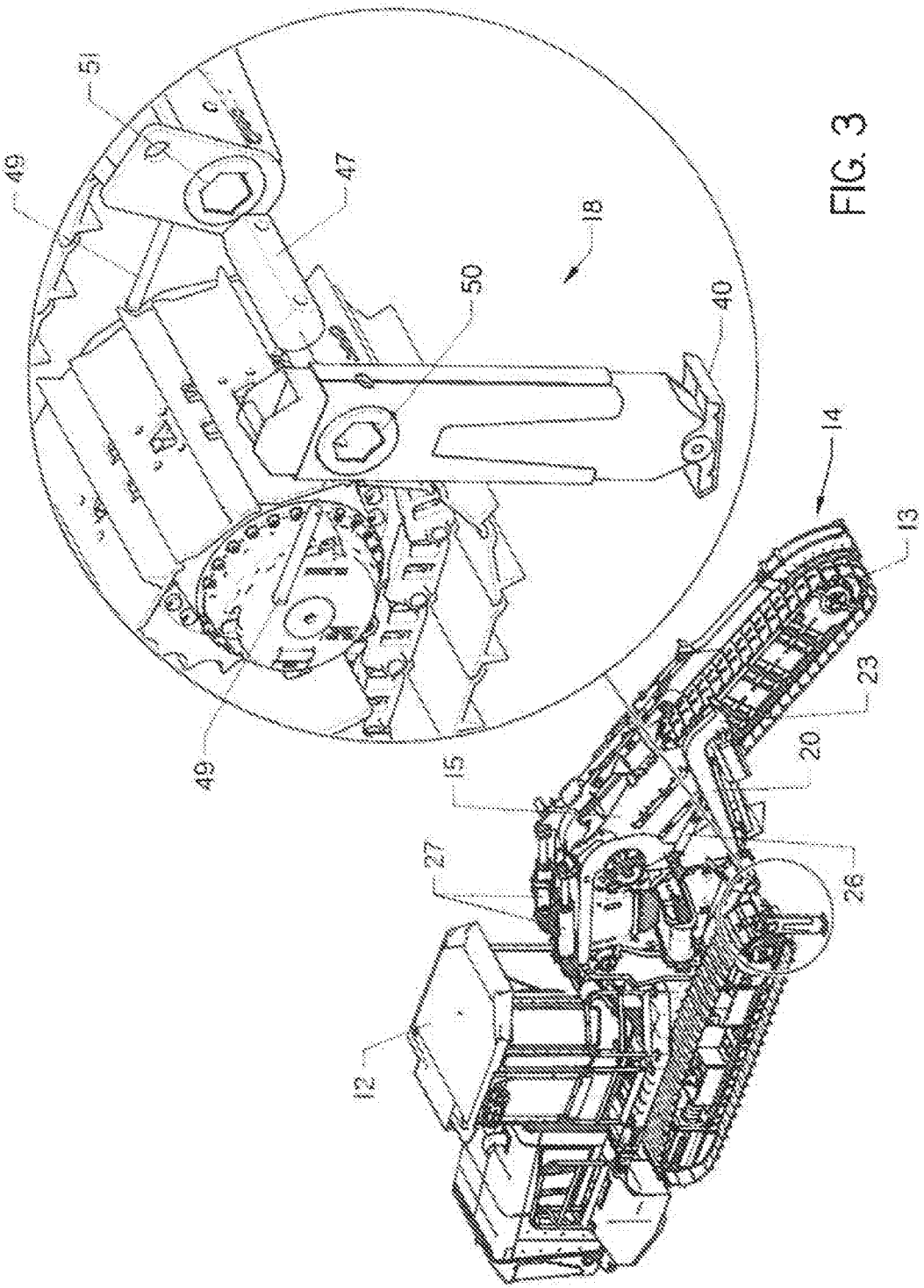

FIG. 3

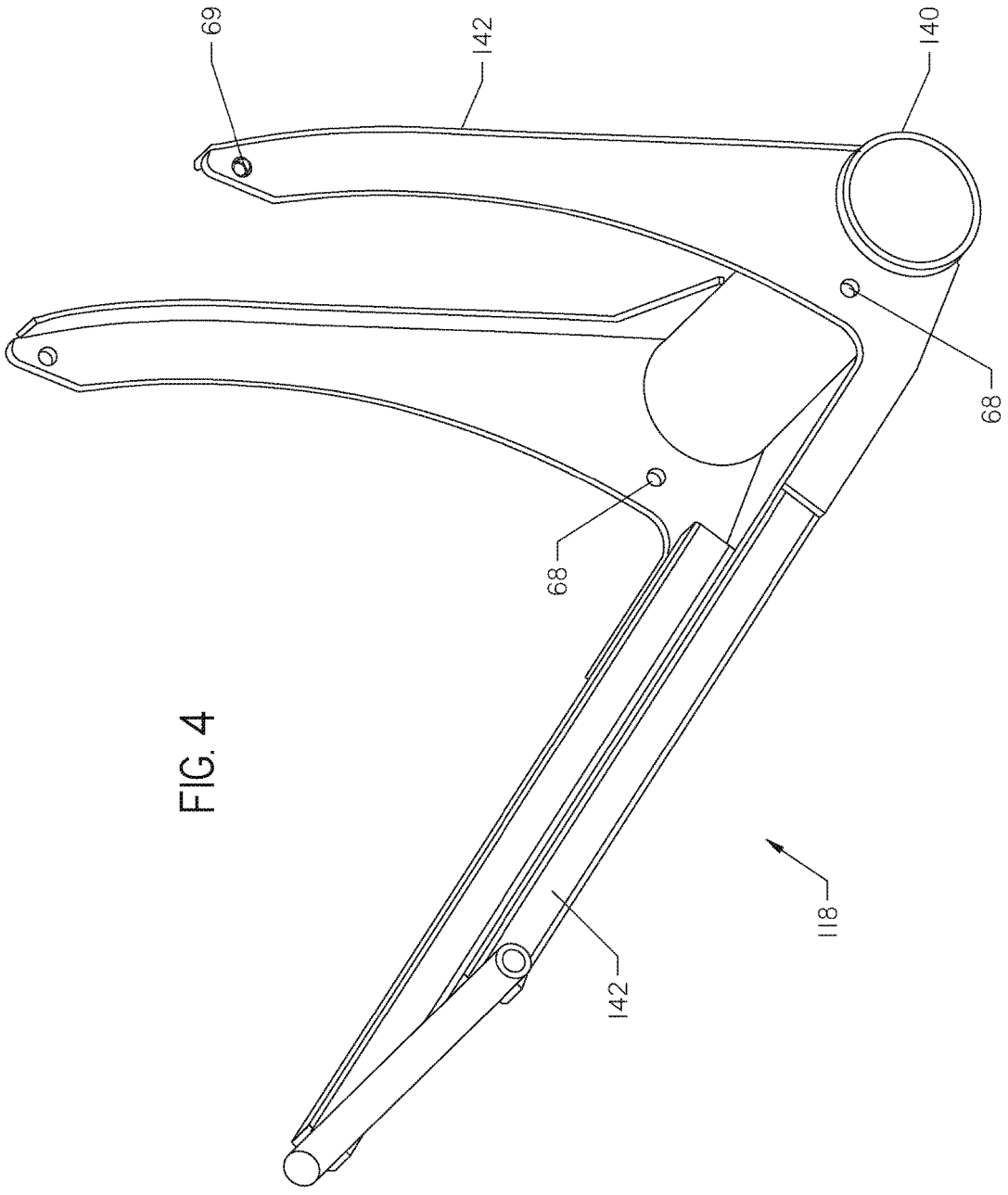

FIG. 4

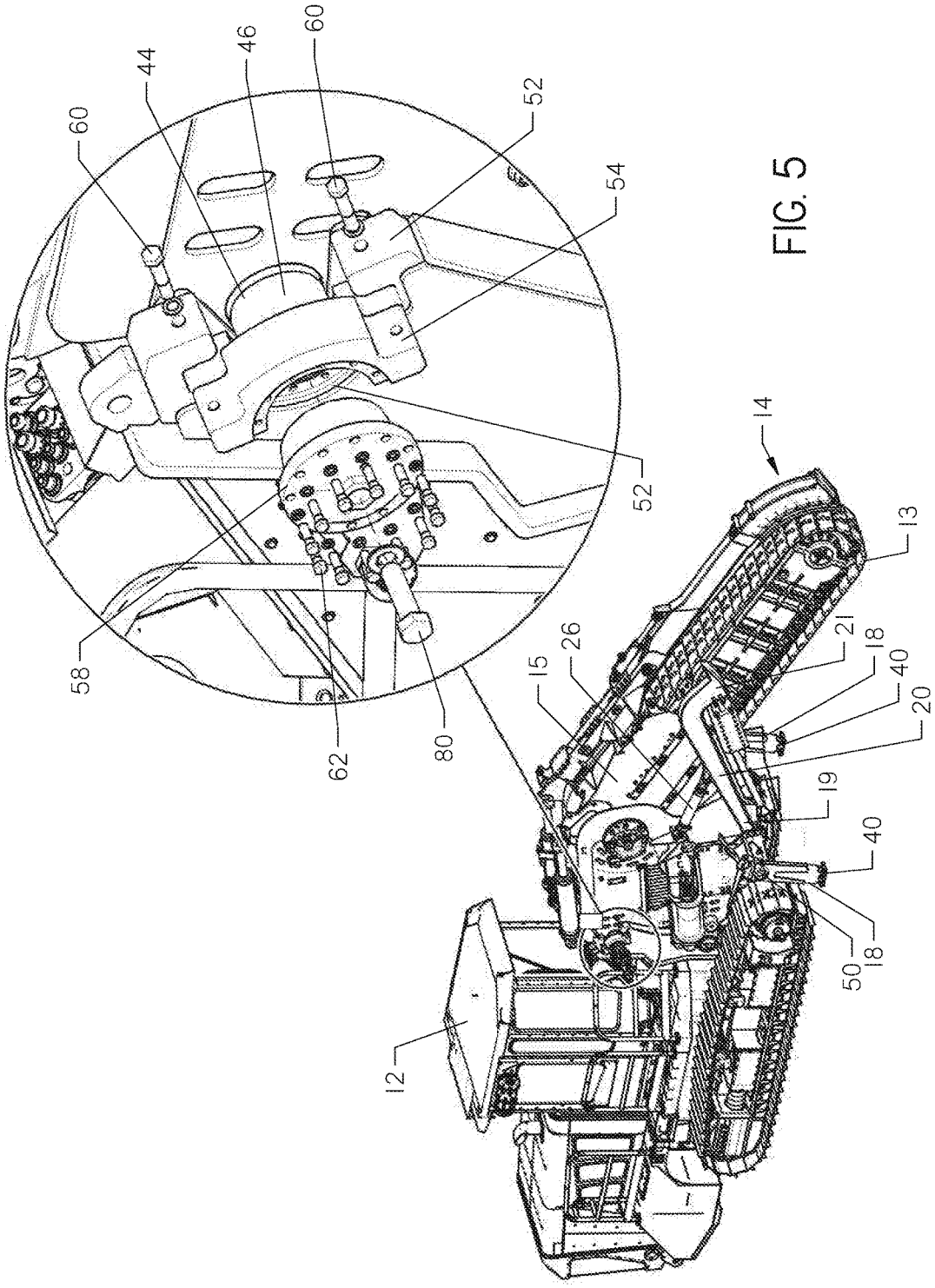

FIG. 5

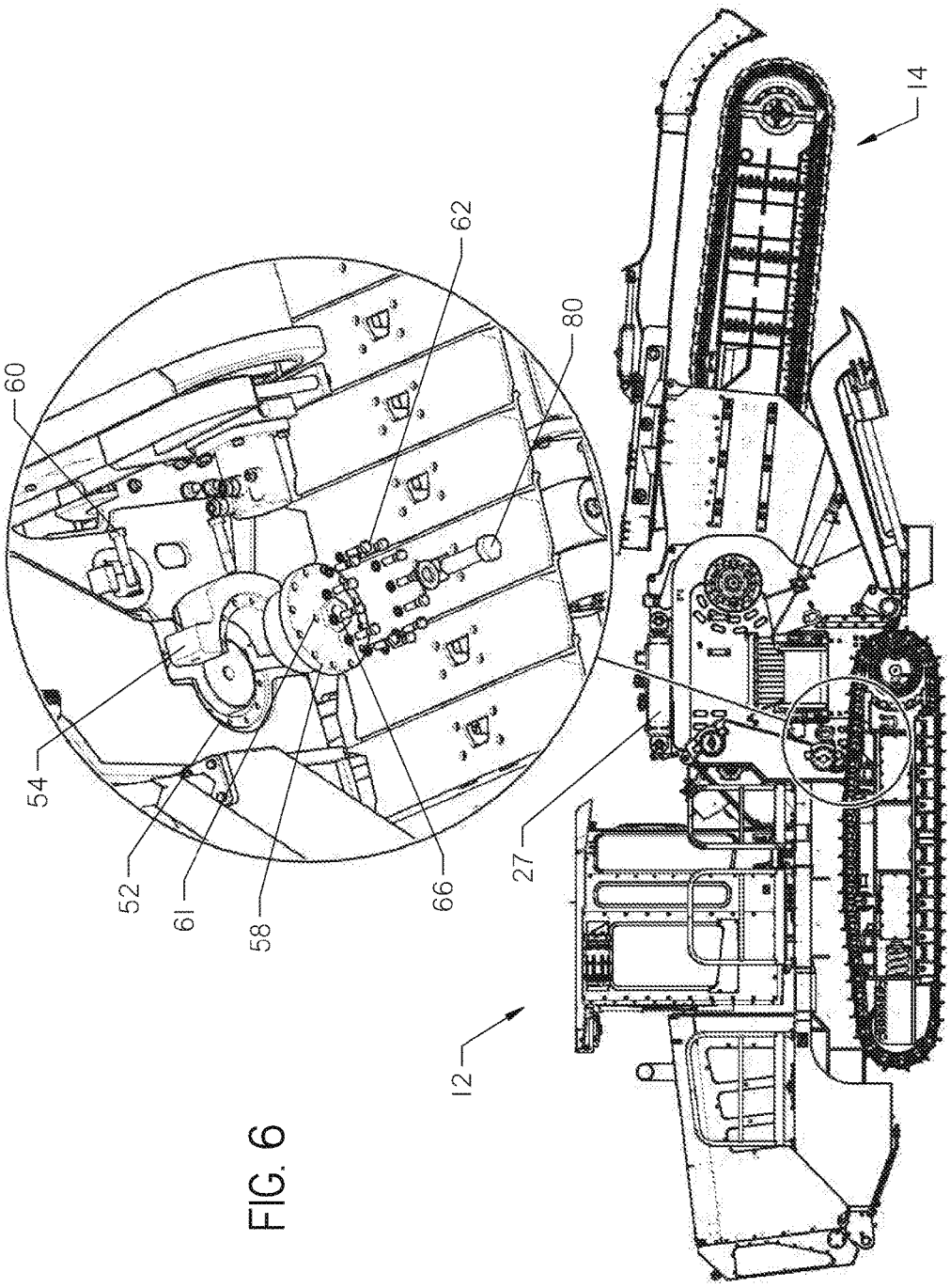

FIG. 6

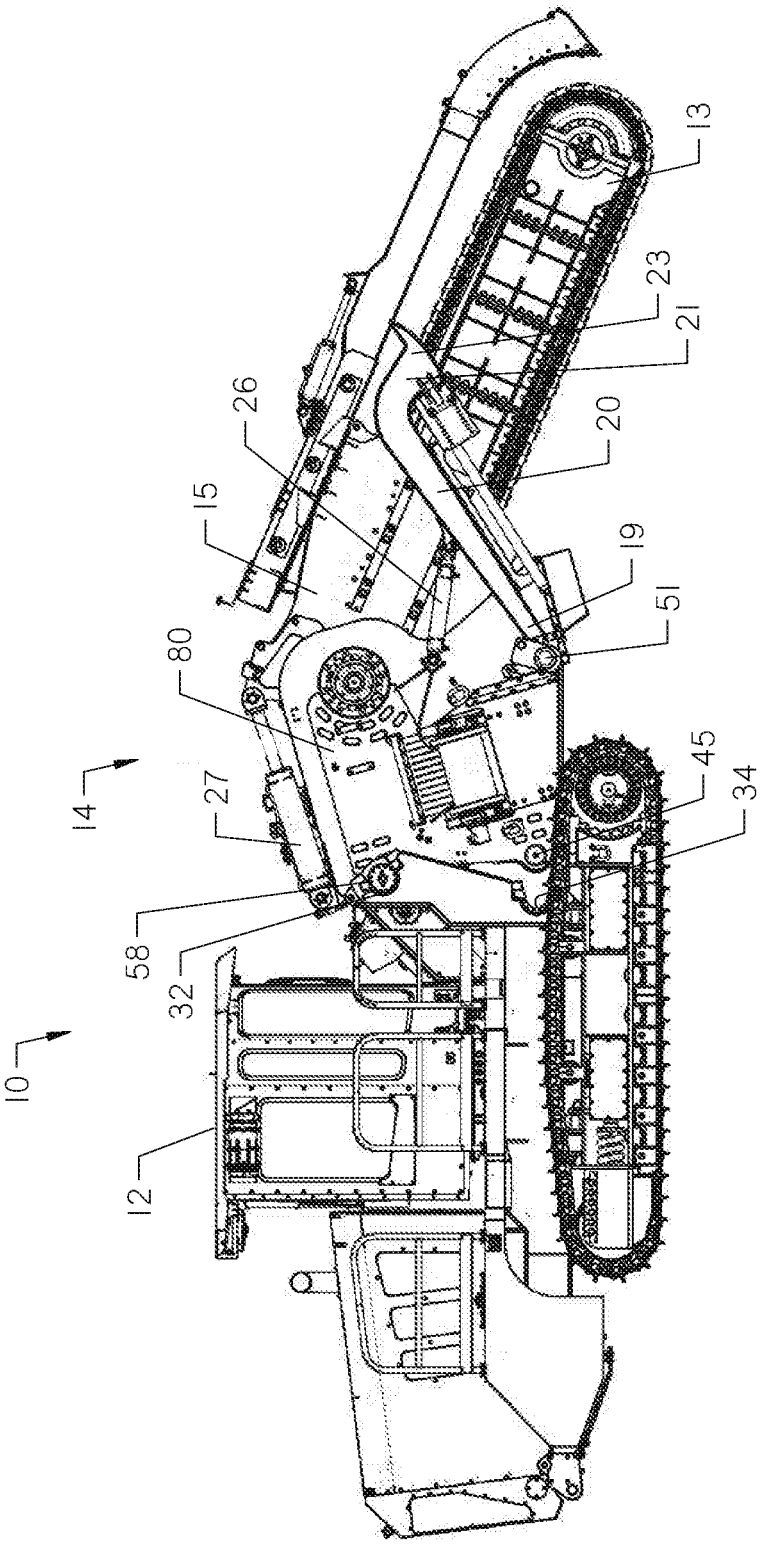

FIG. 7

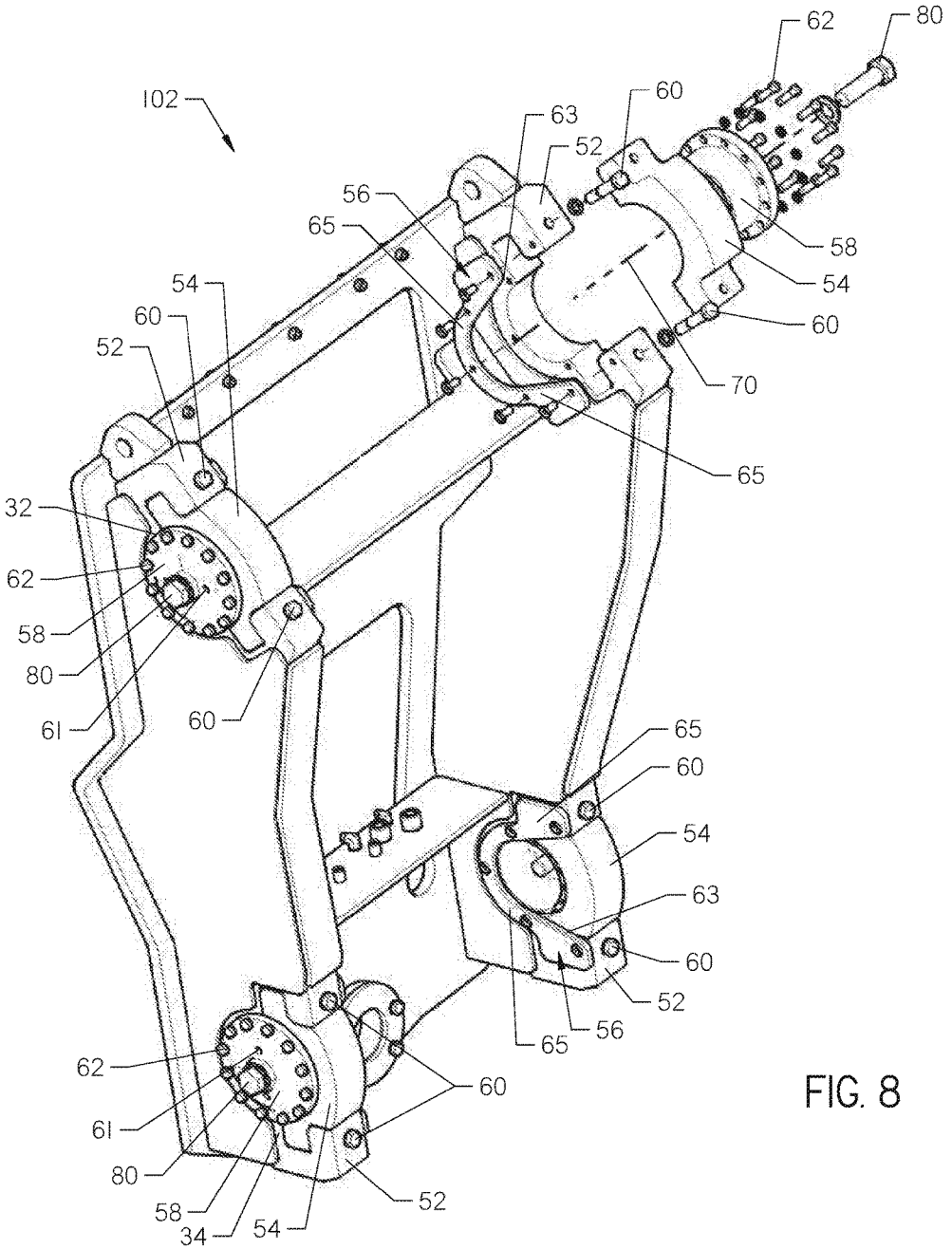
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FIG. 8

GROUND-ENGAGEABLE ATTACHMENT FOR A VEHICLE

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 62/374,725 filed Aug. 12, 2016, the entire contents of which are incorporated herein by reference.

SUMMARY

An apparatus comprises a frame, an elongated positioning arm, a pivot fixture, a coupling assembly, and a ground-engageable work attachment arm. The positioning arm extends from the bottom of the frame and comprises a first end pivotally attached to the frame and a second end supporting an enlarged ground-engageable shoe. The pivot fixture is suspended from the bottom of the frame and comprises a ground-engageable pivot point at its lower extremity. The coupling assembly is configured to join the apparatus to a self-propelled land travel vehicle. The apparatus has no ground-contacting motive elements.

A work machine comprises a chassis, a track frame and a work attachment. The chassis has a rearwardly-disposed cradle assembly. The track frame movably supports the chassis. The work attachment is connected to the cradle assembly of the chassis. The work attachment comprises a frame, an elongated positioning arm, and a pivot fixture. A portion of the frame may be actuated to engage the ground. The positioning arm is pivotally attached to the frame at a first end comprising a ground-engageable shoe at a second end. The pivot fixture is suspended from the bottom of the frame and comprises a ground-engageable pivot point at its lower extremity. The attachment frame has no ground-contacting motive elements.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevation view of a work machine. The attachment is connected to the vehicle.

FIG. **2** is a side elevation view of the work machine of FIG. **1**. The attachment is disconnected from the vehicle.

FIG. **3** is a perspective view of the work machine of FIG. **1** including a detailed view of a pivot fixture and its point of connection to the attachment.

FIG. **4** is a perspective view of an alternative embodiment of a pivot fixture.

FIG. **5** is a perspective view of the work machine of FIG. **1**, including a detailed perspective a detailed perspective view of the coupling assembly.

FIG. **6** is a partial side view of the work machine of FIG. **1**, including a detailed perspective view of the same coupling assembly shown in FIG. **5**.

FIG. **7** is a side elevation view of the work machine of claim **1**. The attachment is partially disconnected from the vehicle.

FIG. **8** is a perspective view of the coupling assembly of the work machine of FIG. **1**.

DETAILED DESCRIPTION

FIGS. **1-3** and **5-7** show a work machine **10** with a self-propelled land travel vehicle **12** and an attachment **14**. The vehicle **12** is supported on a track assembly **16**. The attachment **14** is supported by a retractable pivot fixture **18** (FIG. **2**) and an elongated positioning arm **20**. The attachment **14** shown in the Figures is a trencher. It includes a frame **80** having a ground-engageable arm **15**, which supports an endless chain **13**, which may be selectively positionable on the ground. Other attachments usable in the work machine **10** include, but are not limited to, a dirt trencher, rock trencher, bucket wheel, rock saw or cable plow. Typically, work attachments **14** have no ground contacting motive elements.

The ground-engageable arm **15** as discussed herein is largely used to manipulate or lift the position of the attachment **14**. However, the arm **15** may be an operable portion of the work machine **10**. When assembled, as shown in FIG. **1**, the arm **15** is used to uncover a trench through operation of the work machine **10**.

Hydraulic lines (not shown) connect motor **28** on the attachment **14** with the prime mover of the vehicle **12**. The attachment **14** and vehicle **12** are connected at a coupling assembly **100**. The coupling assembly **100** may comprise a cradle array **102** located at a rearwardly-disposed portion of the vehicle **12** and a rod array **104** (FIG. **2**) disposed on the attachment **14**.

The positioning arm **20** may be raised and lowered by a hydraulically-actuated arm cylinder **26**. The ground-engaging arm **15** may be raised and lowered by a hydraulically-actuated frame cylinder **27**. The motor **28** may power the frame cylinder **27** and the arm cylinder **26**. The arm **20**, frame cylinder **27**, and arm cylinder **26** are preferably duplicated on each side of the attachment **14**.

With reference now to FIGS. **2** and **3**, the attachment **14** and vehicle **12** are shown as detached. The attachment **14** is supported by a pivot fixture **18** and the positioning arm **20**. Support for the attachment **14** while decoupled and free-standing can be supplemented by the ground-engageable arm **15**. The pivot fixture **18** comprises a ground-engageable pivot foot **40**. The ground-engageable pivot foot **40** is located at the lower extremity of the pivot fixture **18** and contacts the ground during the coupling process. The pivot foot **40** is preferably flat to provide support for the attachment **14** when free-standing, but allows rotation over the ground-engageable pivot foot to aid in coupling of the attachment to the vehicle **12**.

The elongated positioning arm **20** comprises a powered arm with a first end **19** pivotally attached to the frame and a second end **21** supporting an enlarged ground-engageable shoe **23**. Extension of arm cylinder **26** causes the shoe **23** of positioning arm **20** to engage the ground. Once thus engaged, the positioning arm **20** provides support and stability to the attachment **14** when detached from the vehicle **12**. Further, the positioning arm **20** may operate with the arm **15** to pivot the attachment **14** about the pivot foot **40**. The shape and size of the elongated positioning arm **20** may vary depending on the shape and size of the attachment **14**. The positioning arm **20** may be bent between its first **19** and second ends **21**.

The pivot fixture **18** may take a number of different forms. With reference to FIGS. **2** and **3**, the pivot fixture **18** is a kickstand device attached to the attachment **14**. The pivot fixture **18** may be removably connected to the attachment **14** by means of a shank **47**. The shank **47** conforms at one end to a socket **51** formed in the attachment **14**, and at the other end to a socket **50** formed in the pivot fixture **18**. As shown, the shank **47** and sockets **50**, **51** are hexagonal. The shank **47** fits into the sockets **50**, **51** and clevis pins **49** or other connectors secure the shank **47** in place. As shown in FIG. **3**, two pivot fixtures **18** may be utilized, laterally spaced on the attachment **14**. During operation of the work machine

10, the pivot fixture 18 may be removed (FIG. 1) or may be rotated relative to the shank 47 for unobtrusive storage on the attachment 14.

With reference to FIG. 4, an alternative embodiment of the pivot fixture 118 is shown. The pivot fixture 118 comprises a ground-engageable pivot point 140 and two legs 142. The legs 150 are joined at pivot point 140 and form a V-shaped structure. The legs 142 may be connected opposite the pivot point 140 to the attachment 14 by pins (not shown). The fixture 118 may extend from below the attachment 14 when the pin is disposed through holes 69. The fixture 118 may be retracted relative to the attachment when the pins are attached to holes 68. When extended, the legs 142 cause the ground-engageable pivot point 140 to extend from the attachment 14. The legs 142 of the pivot fixture 118 create a triangular cross sectional shape of the pivot fixture 118. Thus, the attachment 14 can pivot about the foot 140.

The pivot fixtures 18, 118, may be designed to be retracted or removed when the attachment 14 and vehicle 12 are not in the coupling process. The pivot fixture 18 may alternatively be designed such that it is not retractable or removable but still does not contact the ground while the work machine 10 is not being coupled or decoupled. As shown in FIG. 2, the pivot fixture 18 is suspended from the bottom of the attachment 14 and situated on the opposite side of the first end 19 of the positioning arm 20 from the shoe 23.

With reference again to FIG. 2, the cradle array 102 comprises a top cradle 32 and a bottom cradle 34 formed in the vehicle 12. The rod array 104 further comprises a top rod 44 and a bottom rod 45 disposed on the attachment 14. The top rod 44 conforms to the top cradle 32, while the bottom rod 45 conforms to the bottom cradle 34. While the invention will be discussed with rods formed on the attachment and cradles on the vehicle, an opposite configuration may be utilized without departing from the spirit of the invention.

After arm 15 engages the ground, the attachment 14 may be pivoted around pivot 40 by extension of frame cylinder 27. The positioning arm 20 may be used in concert with the ground-engaging arm 15 to stabilize the attachment 14 during coupling. The attachment 14 is thus pivoted back so that rod 44 is disposed in cradle 32.

With reference now to FIGS. 5 and 6, the connection between the top cradle 32 and top rod 44 is shown in detail. The top rod 44 comprises bushings 46 that are affixed to the rods and facilitate connection to the cradle 32. Bushings 46 may also prevent galling of the coupled rods 44, 45 and cradles 32, 34 in the coupling assembly 100. The cradle 32 comprises a fixed component 52, a locking component 54, and an eccentric cap 58. The eccentric caps 58 may further be secured to the fixed component 52 and locking component 54 by securing pins 62. The pins 62 pass through holes in the cap 58 into the fixed component 52 of the cradle 32.

The eccentric cap 58 has a bore 66. The cap 58 secured to the bushing 46 of the rod 44 by a rod bolt 80. The bushing 46 allows relative rotation between the cap 58 and the rod 44, allowing the rod 44 to act as a pivot axis 70 (FIG. 8) for the attachment 14. The cap 58 is designed such that the bore 66 is slightly offset relative to the centerpoint of the cap. This eccentricity facilitates adjustment between the pins 44, 45 and rotation of the pin 44 within the top cradle 32.

The locking component 54 may be secured into place relative to the fixed component 52 by pins 60. In this configuration, the locking component 54 physically surrounds the rod 44 and the cap 58, securing it within the top cradle 32.

While the discussion of FIGS. 5 and 6 has focused on the top cradle 32 and top rod 44, it should be understood that the bottom cradle 34 and bottom rod 45 are configured identically.

With reference to FIGS. 7 and 8, the top rod 44 is secured within the top cradle 32 by cap 58. The positioning arm 20 is raised and the pivot fixture 18 (FIG. 2) is removed. The frame cylinder 27 adjusts the ground-engaging arm 15, pivoting the attachment 14 about the top cradle 32. Preferably, gravity causes the bottom rod 45 to enter the bottom cradle 34 when the arm 15 is not engaging the ground. The bottom cradle 34 and bottom rod 45 may then assembled in the same way as the top cradle 32 and the top rod 44.

With reference now to FIG. 8, a cradle array is shown. The cradle array 102 comprises the top cradle 32 and the bottom cradle 34. As shown, each side of each cradle 32, 34 has its own cap 58 and locking component 54 for fitting the rods (not shown) to the respective cradle 32, 34.

As shown, the top cradle 32 is set at an angle so that the fixed component 52 opens upwards. The bottom cradle 34 is set such that its fixed component 52 has a substantially vertical opening. While this configuration is advantageous in that it limits force on pins 60, 62 during attachment, it should not be viewed as limiting. For example, each of the cradles 32, 34 could have a substantially vertical opening. Such a configuration could prove useful if the bottom cradle 34 were joined to the attachment 14 before the top cradle 32. In that situation, an upward directed opening could ease assembly.

A coupling guide 56 is affixed to the cradles 32, 34. The coupling guide 56 centers the rods 44, 45 (FIGS. 2, 5, 6) on the cradle array 102. The coupling guide 56 is defined by an upper mouth 63 that is at least as wide as the mouth of the fixed component 52. The upper mouth 63 inwardly converges along guide elements 65. In FIG. 8, the coupling guide 56 is a U-shaped plate aligned with the fixed component 52 of the cradle, though other configurations may be used. The coupling guide 56 may be U-shaped, with each leg of the "U" serving as a guide element 65.

After the cradle array 102 of vehicle 14 is aligned with the attachment 14, the locking component 54 is slid into place within the fixed component 52 and secured with pins 60. The rods 44, 45 are then locked into place by connection of the eccentric caps 58.

In operation, a freestanding attachment 14, as shown in FIG. 2, may be coupled to the vehicle 12. The vehicle 12 is positioned with its cradle array 102 facing the rod array 104 (FIG. 2) of the attachment 14. The vehicle is operated so as to align cradle array 102 with the attachment 14. The attachment 14 is supported by the pivot fixture 18, the arm 15, and the positioning arm 20. Extension of the cylinders 25, 27 causes the positioning arm 20 and arm 15 to engage the ground. As extension continues, the attachment 14 rotates about pivot 40 and arrives at a coupling configuration, in which the top rod 44 is aligned with the top cradle 32. Once this configuration is reached extension of the cylinders 26, 27 may be halted.

The rods 44, 45 and cradles 32, 34 of the coupling assemblies 100 are secured to each other by installing cap 58 with pins 62 and rod bolt 800 and the locking component 54 with pins 60 (FIG. 8). At this point in the coupling process, the work machine 10 is in the configuration of FIG. 7. The positioning arm 20 may be raised from the ground and the pivot fixture 18 removed or retracted. The frame cylinder 27 then may raise the ground-engaging arm 15, lowering the bottom rod 45 into the bottom cradle 34. The connection between bottom rod 45 and bottom cradle 34 may be secured

in the same way as top rod **44** and top cradle **32**, and the coupling assembly **100** between the vehicle **12** and attachment **14** is then complete. The assembled work machine is shown in FIG. **1**.

As shown in FIG. **1**, while the attachment **14** and vehicle **12** are coupled, the positioning arm **20** should be maintained above ground level. Once the vehicle **12** and attachment **14** have assembled, the attachment **14** may be made operational. Thus, when the attachment **14** is a trencher, as in the Figures, the trenching chain **13** may be operated to uncover a trench. The attachment **14** should not operate during coupling and decoupling.

The work machine **10** may be decoupled into its two parts by performing the above steps in reverse. Once the positioning arm **20** has been raised, the ground-engageable arm **15** should be lowered to contact the ground. Engagement of arm **15** with the ground reduces the load on the bottom rod **45** in the bottom cradle **34**. This reduced load allows the securing pins **62**, eccentric cap **58**, and rod bolt **80** to be safely removed from the bottom rod **45** and bottom cradle **34**.

In embodiment shown in the Figures, the eccentric cap **58** has tapped holes **61** (FIG. **8**). The tapped holes can be used to help free the eccentric cap **58** from a coupled rod and cradle, by allowing access to the coupled rod through the cap **58**. The locking component **54** of the bottom cradle **34** is removed releasing the bottom rod **45** from the bottom cradle **34**.

The frame cylinder **27** pushes the ground-engaging arm **15** against the ground, pivoting the attachment **14** about the top rod **44** as shown in FIG. **7**. The attachment **14** should be pivoted far enough that the pivot fixture **18** can be installed on or lowered from the attachment **14**.

Once the pivot fixture **18** has been attached, the arm **15** can be raised until the pivot foot **40** contacts the ground. Engagement of the pivot fixture **18** with the ground reduces the load on the coupled top cradle **32** and top rod **44**. The reduced load on the coupled top cradle **32** and rod **44** allows the securing pins **62**, eccentric cap **58**, rod bolt **80** and locking component **54** to be removed. The released top rod **44** can now be moved out of the top cradle **32** by raising the arm **15** until the top rod **44** is free of the top cradle **32**. Once the attachment **14** is freestanding the positioning arm **20** can be lowered to increase stability of the attachment **14** in the orientation shown in FIG. **1**.

The prime mover of the attachment, motor **28**, may be powered by components of the vehicle **12**. Hydraulic cables or other power lines may be disconnected upon decoupling between the vehicle **12** and attachment **14**.

Decoupling the vehicle **12** from the attachment **14** allows the work machine **10** to be transported in multiple pieces. Further, decoupling the attachment allows for to modularity, where vehicles **12** may be utilized with multiple attachments **14**. One of skill in the art will appreciate that one could make modifications to the various parts, elements, steps and procedures described herein without departing from the spirit of the invention as defined in the following claims.

The invention claimed is:

1. An apparatus, comprising:
- a frame;
- an elongated positioning arm extending from the bottom of the frame comprising:
  - a first end pivotally attached to the frame; and
  - a second end supporting an enlarged ground-engageable shoe;
- a pivot fixture suspended from the bottom of the frame, comprising a ground-engageable pivot point at its lower extremity;
- a coupling assembly configured to join the apparatus to a self-propelled land travel vehicle; and
- a ground-engageable work attachment arm supported by the frame;
- wherein the apparatus has no ground-contacting motive elements.

2. A system comprising:
- a self-propelled land travel vehicle; and
- the apparatus of claim **1**, joined to the vehicle at the coupling assembly.

3. The system of claim **2** further comprising at least one cradle attached to the vehicle to join the apparatus to the coupling assembly.

4. The system of claim **3** wherein the coupling assembly comprises a pair of parallel rods.

5. The system of claim **4** further comprising a cap for connecting one of the cradles to one of the pair of parallel rods.

6. The system of claim **5** wherein the cap defines a bore for attaching a rod bolt to one of the pair of parallel rods, wherein the bore is not disposed at a centerpoint of the cap.

7. The system of claim **3** further comprising a coupling guide affixed to the at least one cradle and having an upper mouth situated above one or more inwardly-converging guide elements.

8. The system of claim **4** wherein the at least one cradle comprises a fixed component and a locking component.

9. The system of claim **8** wherein the parallel rods are secured within the cradles when the locking component is secured to the fixed component.

10. The apparatus of claim **1** wherein a bend is formed in the arm intermediate its first and second ends.

11. The apparatus of claim **1** wherein the ground-engageable work attachment arm is an endless trenching chain.

12. The apparatus of claim **1** wherein the pivot fixture has a triangular cross sectional shape.

13. The apparatus of claim **1** wherein the pivot fixture is retractable within the frame.

14. The apparatus of claim **1** wherein the pivot fixture is removable from the frame.

15. The apparatus of claim **1** wherein the coupling assembly comprises a pair of parallel rods.

16. The apparatus of claim **15** wherein a bushing is affixed to each end of each of the rods.

17. The apparatus of claim **1** wherein the pivot fixture is suspended from the frame proximate the first end of the positioning arm.

18. A work machine comprising:
- a chassis having a rearwardly-disposed cradle assembly;
- a track frame movably supporting the chassis; and
- a work attachment connected to the cradle assembly of the chassis, the work attachment comprising:
  - a frame, wherein a portion of the frame may be actuated to engage the ground;
  - an elongated positioning arm pivotally attached to the frame at a first end comprising a ground-engageable shoe at a second end; and
  - a pivot fixture suspended from the bottom of the frame, comprising a ground-engageable pivot point at its lower extremity;
  - wherein the attachment frame has no ground-contacting motive elements.

19. The work machine of claim 18 wherein the work attachment comprises a pair of spaced-apart rods disposed within the cradle assembly of the chassis.

20. The work machine of claim 18 wherein the pivot fixture is removable from the frame.

21. The work machine of claim 18 wherein the portion of the frame actuated to engage the ground is a trencher boom.

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